File no. 126 & 24

App. F. IX-4

1926-27 (must)

File No. 126-24

Previous References

126-26 & 1-8

~~126-26 & 9-11~~

Serial Nos. 9-24

Preserved

Later References

Bmg 126-30-25-34-38

General and Revenue Secretariat.

Serial Nos. 16.

Part B for April 28

SUBJECT

Preservation of images in Relief and Wakhid Kempsa

---

ordered be recorded

14/4/28

GENERAL AND REVENUE SECRETARIAT.

NOTES.

File No. 126-26

FILE HEADING.

P/ Preservation of images in Belur and Halebid Temples.

From

H. Mys. Govt.

No. C. 1189 Dated 1-9-27 Received

Diary No. 241	Enclos.	Spare Copies.	Serial No. 14

BRIEF ABSTRACT OF LETTER.

Forwards copies of letters dt 4-5-27 & 12-7-27 from Professor H. Kreger of Stockholm, Sweden, on the results of the experiments so far conducted in connection with the preservation of images in the temples at Belur & Halebid

NOTES AND ORDERS.

SC. 15 From the Secretary to the Hon'ble the Resident in Mysore., letter No. 9103 dt 6-7-27

Forwards copy of a letter ~~not~~ from the India Office, No P. 2687 dt 16-6-27 & enclosure in the matter of certain problem. Has dec and requests that the sum of £4/-. paid into the Hon'ble the Resident's to the credit of the Govt of India

NOTES—First Sheet.

WD 1831—GPB—30,000—1-8-21

General and Revenue Secretariat.

Muz File No. 126 of 1926.

Serial No.	
K	The reference to the Muz. Comrs. letter is Sl. no. 4 of the file. No action on this letter of the Muz Comrs is called for.
3	The reference to the Residency letter is Sl. no. 3 in the recorded collection file. A charge of £4/ has to be paid into the Hon'ble the Resident's Treasury, being the cost of making a section & photograph from specimens supplied. No charge has been made for the communication of existing knowledge & technical information by the Building Research station of the Deptt of Scientific and Industrial Research, Westminster.
	The points for orders:-
	1) ~~Accompanied~~ the Report read has to be sent to the Industrial Chemist for information & necessary action thereon: the Muz: Comrs. or a copy of it
	2) Whether the charge of £4/. to be met now should be sanctd. afresh from the Gy. M. Fund or met out of Rs 500 sanctd. in Gy. o. No. 1446-71 Muz 126-26-8 dy 5.2.27 is for orders.
	8/9/27 12/9/27

NOTE—Contn sheet

WD 0324—GPB—60,000—24 5 27

General and Revenue Secretariat. | File No. of 192

Serial No.

The report is sent for perusal It is very interesting as showing how excellent a material soapstone was for building these temples and that our fears for the stone work of the temples is needless.

The more important sentences of the note are underlined in pencil The summary at the end gives the conclusion of the Research Department. We need not remove the lichen, nor need we use any preservative for the stone.

All that has to be done is (1) if the stone has broken and come off sideways anywhere to replace it with that side horizontal (2) if any particular bit is badly broken up to remove it and place new work there, if we have no objection

Whether any such action is necessary may be examined by an officer of the P.W.Dept Necessary action may then be taken The Belur Temple is not likely to have many such stones in bad condition The Halebid temples are said to be in a worse condition

The amount of £ 4 may be paid out of the sum of Rs 500 which have been sanctioned recently A Copy of the note

NOTE—Contn sheet

WD 0824—GPB—60,000—24-5 27

General and Revenue Secretariat. File No. 14— of 192

Serial No.

A

will be sent to the Murrai Council and to the Chief Engineer for Irrigation report on the action considered necessary. The Murrai Council will be asked to pay the amount claimed by the Residency into the Resident's Treasury.

Proposal and orders.

13/9

OFFICE OF THE
BOARD OF REVENUE
13 SEP. 1927
No. 1394

Second Member)

The Comptr may be asked to pay Rs 4. I am not sure if the grant of Rs 500 for this purpose is for this year. If there is any difficulty regarding payment the charge may be met from Genl Improvement Fund.

A copy of the Report may be sent to Mr. S. C. Sastri and he may also be asked what course he recommends in view of the advice given in the report.

Action as proposed at A may also be taken

14.9.27

14/9

3754/14.9.27

ST 1579

NOTE—Contn. sheet

WD 0324—GPB—60,000—24 5 27

General and Revenue Secretariat. | File No. 126 of 1926.

Serial No.

Drafts to the Comptr., to the M.C. & Ch: engr. & Industrial Chemist, are subd.

SD 15/9/27 BL 15/9/27

Issue

MD 16/9

Water & Res

MD 16/9

S.T. 19/9 Draft to Residency is put up.

SD 17.9.27

Dove

MD 17/9

2/6 To the Residency no PA: 358 & 19.9.27 Acknowledge receipt of this letter & state that a sum of Rs 2/6 has been ordered to be paid into the Resident's Tr.

9 To the Comptr no 464 & 19.9.27 Requests that Rs 2/6 may be paid into the Resident's Tr.

28 To the MC No. 487 & 24.9.27 Sends for joint opinion & return the Ch: Engr's Copies of the note by the Dept of Scientific & Industrial Research London.

16/9 To the Ch: Engr. No 484 & 24.9.27 Sends a copy of the note & what Course he will suggest

NOTE—Contn sheet

JM 21/12

WD 0321—GPB—60,000—21 5 27

General and Revenue Secretariat. | Mys File No. 126 of 1926

erial No. 20

From the Mys. Comr.,
letter no. C. 1189 of 22-23 & 22 12 27

Forwards copy of a "Paper" prepared by Mr S. G. Sastry, Industrial Chemist ~~forwarded~~ on the subject of the "Preservation of Stone work in the temples of Belur & Halebid", & forwarded by the Director of Industries & Commerce—

Reference. Letter no. 481 & 24-9-27 to the Mys: Comr.—

The "Paper" prepared by Mr S. G. Sastri is proposed to be read at the next session of the Engrs Association to be held at the Science Institute, & the M C sees no objection to this.

The next proposal is that the drains should be so remodelled as to stop the trickling of rain water over the images. With regard to this the M C. suggests that the P.W.D may be requested to take necessary action—

Subd for orders. The proposal may be approved

29/12

28/12/27

Secretary

agree
(illegible)
30 12 27

DEC. 1927
3524.

NOTE.—Contn sheet

General and Revenue Secretariat.

File No. 126 of 1926

Serial No.

Diffs. sent up one to M. C & another to Ch. Engr.

89 — 4/1/28 Ed. 4.1.28

Done mw 7/1

21 To Mun Comm^r
No 1120 Dt 13.1.28
State that there is no objn for the paper being read at the Session of the Engrs Associates

22 To
Ch Engr No 1122 Dt 13.1.28
forwards extract from the above Paper & requests him to take action for remodelling the Drains as indicated therein

23 From the Ch: Engr.,
letter no. 7524 Dt 11.2.28
Reports the action taken to remodel the drains referred to and also to prevent decay and deterioration of the two temples.

The Supdg Engr reports that he made a detailed inspection of the temples on the 26th Jany 28, with the Ex Engr and S.D.O Rangoon.

D 10/11

Note — Contn sheet

General and Revenue Secretariat. File No. of 192

Serial No.

Full instructions to attend to the drainage & other works in this dry weather.

References - Letter to Ch. Engr. dy 13.1.28

In this office letter no. 48/Mun 176-26-28 dy 14.2.28

Q 24 9.2) The Mun Engr and the Chief Engr were asked to submit a joint report on the action considered nec. in the note sent up by the Dept. of Scientific & Industrial Research, London, on the subject of "Preservation of Stone work Temples of Belur & Halebid". - Now a joint report has not been rec'd it is clear from the correspondence ending with the Ch. Engr's letter no. 2524 dy 11-2-28 that nec. action is being taken by the P.W.D to remodel the drains & also to prevent decay & deterioration of the temples.

No further action seems nec. The papers may be filed after perusal.

14-2-28

A copy of the Chief Engineer's letter may be forwarded to the Mun Engr with its enclosure

2nd Member

15/2

Mean while the papers may be referred to the Mun Engr with enclosure

15/2

Yes

17.2.28

Secy - please

15/2

NOTE.—Contn sheet

FEB. 4585

W D 0324—SPL—60,000—24 5 27

General and Revenue Secretariat.

File No. 126 of 1926.

Serial No.	
	Draft. submd 20.2.28 20/2/28
24	To. Mur Coen^t No 1484 & 28.2.28 Forwards copy of his Ce-Engrs letter dt 8-2-28.

NOTE—Contn. sheet.

WD 2293—GPB—10,000—4-5-27

OFFICE OF THE MUZRAI COMMISSIONER
IN MYSORE.

5761
11/4

Bangalore,...9th..April.....192 7.

FROM

P.G. D'Souza Esq., P.A., P.L.,
MUZRAI COMMISSIONER IN MYSORE.

GEN. & REV. SECRETARIAT.
12 APP 1927
MUZRAI

D1476
Over 126-26-9
Misc 208-75-10

To

The Secretary to Government,
Financial Department.

SIR,

Referring to G.O. No.1446-7/M.F.126-26-8 dated 5th February 1927, I have the honour to forward herewith for kind information of Government, copy of a letter dated 9th March 1927 received by Mr.S.G. Sastry from Prof. H. Kreuger of Stockholm re. experiments that are being conducted for the preservation of images in the Belur and Halebid temples.

I have the honour to be,
Sir,
Your most obedient servant,

Muzrai Commissioner.

VSM.

Subd
M.F. 126-26 containing the above G.O. is put up - No action on this letter seems called for.

12-4-27

12/4

For perusal Thro
Third Member 14/4

14/4

OFFICE OF THE
SECOND MEMBER OF COUNCIL.
14 APR. 1927
6367

OFFICE OF THE MUZRAI COMMISSIONER IN MYSORE.
No. C 1189 of 1926-27
APR 4 1927

Copy of letter dated 9th Mars. 1927 from Prof. H. Kreuger, Stockholm to Mr. S.G. Sastry, Govt. Soap Factory, Bangalore.

I am in receipt of your letter No.3289 from which I see that you will try to get some photos of the temples at Belur and Halebid.

The stone-samples arrived some days ago in good condition. I have just arranged for them at my laboratory and hope to get a good solution of the problem.

It should be of interest to have a detailed information how the joints between the stones are made. I suppose the stones are laid close together without mortar. At least I could not see any mortar on the samples. Do you know the age of the temples?

In order to be quite sure of a right treatment I think that my investigations will take three or four months. After that time, perhaps earlier, you will hear from me.

I suppose it later on will be necessary for me to visit the places where the temples are built and I suppose this will coincide with your opinion.

All the ingredients, which I intend to use, you can get in India and they are not expensive at all.

No patents and no licences.

No. 3940 -. 4th April 1927.

Copy of the above together with my reply to Prof. Kreuger

F.T.O.

23

OFFICE OF THE SECRETARY TO GOVERNMENT
REVENUE DEPARTMENT AND SECRETARY OF COUNCIL.
21 JULY 1927.
No. 4675

OFFICE OF THE MUZRAI COMMISSIONER
IN MYSORE.

Bangalore, 5th July 1927

From

A.K. Syed Taj Peeran Esq., B.A.,
Muzrai Commissioner in Mysore.

To

B. Sreenivasa Iyengar Esq., B.A., B.L.,
Financial Secretary to the Government of
His Highness the Maharaja of Mysore.

SECRETARIAT. 13 JUL 1927

MUZRAI
D.No 47

Muz 126-26-10

Sir,

Referring to the concluding portion of your letter No. 1099/M.F.126-26-5 dated 11th December 1926, I have the honour to forward herewith for favour of information copy of letter No.579 dated 4th June 1927 from the Executive Engineer, Hassan Division (received with Deputy Commissioner's letter No.C.399-26 dated 9-6-27) intimating that needful action has been taken for preserving the two female figures in the North East and North West corners of the Pelur temple.

I have the honour to be,
Sir,
Your most obedient servant,

Muzrai Commissioner.

The file on the subject is put up - The reference is at Sl.No.5. If approved, the M.C may be requested to inform the Industrial Chemist of the action taken to preserve the above figures -

19/7/27 Secd Member

Copy sent from Hassan

Draft subd.

SD
26.7.27. 26.7.27

Issue
mw
27/7.

126 - 26 - 11

To. Mun Concerns
No 228 dt 1.8.27

Requests that
the Industrial Chemist
may be informed
of the decision
taken

Executive Engineer, Hassan Division to the Deputy Commissioner, Hassan District.

With reference to your Memo No. 399-26/Mdz, dated 25th December 1926, forwarding a copy of letter C. 1189/22-23, dated 17th December 1926 from the Muzrai Commissioner to the address of the Chief Engineer in Mysore, regarding the action to be taken on preserving the two images in the north/eastern and north-western corners of the Belur temple, I have the honor to intimate that needful action has been taken in the matter.

C O P Y.

Superintendent,
Muzrai Branch.

Keep = file

BJECT.....

.....

.....

Section mur

File No. 126-26

Serial No. 11

No. G.A. 8

Diary No. of letter replied to....47.....

To

The Mun: Comr in mysore
Bangalore.

General and Revenue Secretariat
(Mun)
the *192*

Sir,

Date of issue 1-8-27

With reference to the correspondence ending with your letter No. C 1189 of 22-23 & 12 7-27 intimating that ~~needful~~ necessary action has been taken for preserving the two female ~~figures~~ statuettes in the North-east and north-west corners of the Belur Temple, I am directed to request that the Industrial Chemist may be informed of the action taken.

Signed by Mr M Venkatesa Iyengar

List of enclosures.....

2 have c/c

Secretary,
To Govt

Copied by.....

Examined by SD 27/7

SD 26.7.27

over

5—GPB—31,000—24-12-25

SD 26-7-27

C 1189/22-23 Office of the Muzrai Commissioner in Mysore.

Dated Bangalore, 10th August 1927.

REVENUE SECRET BRANCH
GEN 13 AUG 1927
MUZRAI
D138

From

A. K. Syed Taj Peeran, Esq., B.A.,
Muzrai Commissioner in Mysore,
Bangalore.

Muz 2/126-26

To

P. Srinivasa Iyengar, Esq., B.A., B.L.,
Secretary to the Government of His
Highness the Maharaja of Mysore,
Financial Department.

Sir,

Referring to correspondence ending with your letter No.228/M.F.126-2611 dated 1st August 1927 directing that the Industrial Chemist might be informed of the action taken in respect of preserving the two female statuettes of the Belur temple, I have the honor to request the return of the Hassan Executive Engineer's letter No.579 dated 4th June 1927 forwarded with this office letter No.1189 dated 12th July 1927, as the same has not been received with your reply.

The Ex Engr's letter referred to is a copy & not original. So, it was not sent

22/8/27

I have the honor to be,
Sir,
Your most obedient servant,

for Muzrai Commissioner.
(About from Station)

Draft covering the paper is put up for approval

19-8-27

352 Enclosure

Rec'd 8/27-8-27
126-26-13

To

The Secretary

Sir

As directed in your letter C 1189/722-23 of 11-8-27, I am directed to forward herewith

Copy of Warrant No 579 Register letter No 579 of 4-6-27 appointing the Jamalpur Statutes & the Rebuilding Temple

I have &c

[illegible]

19-8-27

Office of the Muzrai

Dated Bangalore the 26th August 1927.

1149

GEN. & REV. SECRETARIAT 3 SEP 1927 MUZRAI BANGALORE.

241 Sl. 14

From

A. K. Syed Taj Peeran , Esq., B.A.,

Muzrai Commissioner In Mysore, P A N G A L O R E.

To

B. Sreenivasa Iyengar, Esq., B.A., B.L.,

Secretary to the Government of His Highness

The Maharaja of Mysore, Financial Department.

Sir, Mug 196 - 26

In continuation of this office letter No. C. No. 1189/27-28 date April 1927, I have the honor to forward herewith copies of letters dated 4-5-1927 and 12-7-1927 from Professor H. Kreger of ----- Stockholm on the results of the experiments so far conducted in ------ connection with the preservation of images in the temples at Belur and Halebid, received with the Industrial Chemist's letter of the 19th Instant.

I have the honor to be,

Sir,

your most obedient servant,

Muzrai Commissioner.

Stockho m,

ory, Pangalore.

No. 9 4th April 27.

with the stone you have sent to me.

if were principally a pure physical action

the decay of the stone and not a chemical one.

be of great value if you could give me an

information about the Maximum surface tempreture of the

stone in the sunshine. I also should like to know if it is

is possible that a relatively cold rain may fall when the

surface of the stone is hot.

Is there any difference in the desintegration of the

stone in different parts of the building especially with

regard to such parts which are not exposed to the sun.

"C O P Y"

For Muzral Commissioner.

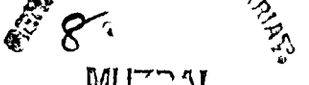
ications should be
he Secretary to
in Mysore, Ban-
by designation and not

No. 9103 ENC. 1
252-1926.

Pol. 208

FROM

Major K. A. C. Evans Gordon,
SECRETARY TO THE RESIDENT IN MYSORE.



MUZRAI
267

To

The Secretary to the Government of Mysore,
mur 126-26-H 15
Financial Department.
Dated Bangalore, 6th Sept. 1927.

Subject.

Request by the Industrial Chemist in charge of the Mysore Government Soap Factory, Bangalore, for an enquiry into certain problems of stone decay.

SIR,

With reference to your letter No.Pol.442/Muz.126-26, dated the 16th November 1926, I am directed to forward a copy of a letter noted in the margin and to request that the sum of £4/- may be paid into the Hon'ble the Resident's Treasury to the credit of the Government of India.

From the India Office, No.P.2687, dated the 16th June 1927, and enclosures.

I have the honour to be,
Sir,
Your most obedient servant,

Major.

SECRETARY TO THE RESIDENT.
SIR

No.

A copy of the foregoing letter is forwarded to the Pay and Accounts Officer, Civil and Military Station, Bangalore, for information.

Sd. K. Evans Gordon,

Major.

SECRETARY TO THE RESIDENT.

requested that in any further communication on this subject the under-mentioned letter and number may be quoted, and the reply addressed to—

The Under Secretary of State for India,
Political Department,
India Office,
London, S.W.1.

P. 2687.

INDIA OFFICE,
WHITEHALL,
LONDON, S.W. 1.

16th June 1927.

Sir,

With further reference to Mr. Lynch Blosse's demi-official letter dated 9th December 1926, No.D.O. 335-I relative to a request by the Industrial Chemist in charge of the Soap Factory, Bangalore, for an enquiry into certain problems of stone decay, I am directed by the Secretary of State for India to forward for transmission to the Mysore Darbar the enclosed Report on the subject which has been received from the Department of Scientific and Industrial Research.

From Department of Scientific and Industrial Research (dated 27th May) with enclosure in original.
To Do. 13th June 1927.

It will be seen that the Department were unable to furnish an estimate in advance of the expenditure in connection with this Report, but that their claim amounts to £4 only. In view of the smallness of the sum involved, the Secretary of State in Council assumes that no objection will be taken to its payment by the Mysore Darbar. He has accordingly sanctioned its refund to the Department of Scientific and Industrial Research, and I am to request that the necessary recovery may in due course be made from the Darbar.

A debit for this amount will be included as an original entry under the head "His Majesty's Imperial Government:- Miscellaneous - Civil" in Schedules of the Inward Account Current for the month of June 1927.

I am, Sir,
Your obedient Servant.

H.W.Garrett.

The Secretary,
Government of India,
Foreign and Political Department.

Department of Scientific and Industrial Research,

16, Old Queen St.
Westminister, S.W.1.

27th May 1927.

Sir,

I am directed by the Committee of the Privy Council for Scientific and Industrial Research to transmit for action by the Secretary of State for India the enclosed copy of a Report by the Director of Building Research on the Preservation of Stonework in the Temples of Belur and Halebid. This Report is the outcome of an application received from the Engineer and Chemist at the Government Soap Factory, Bangalore, which has been the subject of semi-official correspondence concluded with Mr. Wakely's letter of the 6th January 1927 (P.4551) and Sir Frank Heath's semi-official reply of the 13th January.

No charge is made for the communication of existing knowledge and technical information held available at the Building Research Station of this Department, and the only charge in connexion with this Report is one of £4 covering the actual cost of making a section and photograph from specimens supplied. The Committee of Council regret that it was not possible to furnish an estimate of this charge in advance, but in view of its amount I am to express the hope that no difficulty has thereby been occasioned.

The Department will be glad to receive in due course a payable order for the amount stated.

I am, etc.

F.S.Lloyd.

The Under Secretary of State,
India Office,
Whitehall, S.W.1.

Note No. 115.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

BUILDING RESEARCH.

PRESERVATION OF STONEWORK - TEMPLES OF BELUR & HALEBID.

May, 1927.

Director of Building Research,
Building Research Station.
Carston. Herts.

PRESERVATION OF STONEWORK - TEMPLES OF BELUR & HALEBID.

Stone Preservatives.

During the last 70 years, many substances have been used in attempts to preserve stonework by surface treatment, and, at the present time, there is a large number of commercial stone preservatives on the market. Experience has shown that such substances are seldom satisfactory and though, in a few instances, surface treatment may have appeared to be successful, or, at least, to have caused no harm, possibly even throughout the lifetime of those who applied it, it has been left to their successors to realise what irreparable damage was done. Examples of such ultimate damage naturally suggest that extreme care should be exercised before any process is recommended, even if it is apparently successful. In most cases where preservatives have been used, observation has shown, either that the preservative has actually harmed the stone within a comparatively short time, or that the stone has derived no material benefit from the treatment.

Unless the treatment renders the surface absolutely impervious at all points, a consummation almost impossible of realisation in practice, decay is liable to go on beneath the surface, causing the treated face to blister and eventually to flake off. Moreover, a point which is often overlooked is that the protective effect cannot be permanent and the treatment must be repeated from time to time. Though, for aesthetic reasons, it can seldom be used to protect stonework, probably the most satisfactory agent is ordinary

paint and it is generally recognised that a paint coating requires renewal every few years. If such a comparatively efficient and strong coating requires renewal, it is evident that the colourless protective coatings commonly employed for treatment of stone, which are all less efficient than paint, must be renewed at frequent intervals. The flaking and spalling which occurs when painted stonework is neglected, affords positive proof that surface treatment is worse than useless unless it is frequently repeated.

In the present state of our knowledge, therefore, and from general considerations alone, it is impossible to recommend any surface treatment whatever because such treatment is unlikely to prove effective and it may, indeed, increase the tendency to decay and render the buildings extremely unsightly.

It is recognised that it is unsatisfactory to have to make statements of this kind and research on the whole question of stone decay and its prevention is in progress at the Building Research Station, but the nature of the problem is such that it cannot be hoped that any satisfactory method of preserving stone will be evolved in the near future.

Even if a preservative were known which had definitely been proved to be efficient in normal circumstances, it is doubtful whether it could be recommended for the treatment of soapstone, since the stone is so impervious that the preservative would merely form a surface skin which would soon peel off, particularly under the action of tropical sun and rain. By partial immersion in water, specimens of the stone absorbed only 0.43% of their weight in seven days, and even after long boiling and subsequent cooling in water the absorption was only 0.47%.

The extent of decay.

Without seeing either the buildings or detailed photographs, it is difficult to visualise the extent of the decay, but, judging from the specimens received, the extent of weathering is comparatively small, and the presence of lichens shows that the rate of decay must be extremely slow. In all probability, therefore, the decay which has already taken place has occurred after a long period of exposure, and the buildings are unlikely to show any marked increase in deterioration in the near future, in fact it is probable that the durability of any known "preservative" is so short in comparison with the durability of the stone that its application, unless repeated at comparatively frequent intervals, would have no appreciable influence on the life of the building.

Thin section of the stone have been prepared and examined microscopically. These show that the rock consists mainly of talc, with small amounts of calcite and pyrites, and possibly rutile. Incidentally, the rock has been found to contain 0.73% TiO_2. Titanium is commonly used as an index of the extent of weathering and, had it been determined in the original analyses, would have been useful as such. In the present instance, the iron has served the purpose, but in any future analyses, TiO_2 might be determined separately.

Talc is extremely resistant to weathering, but it may eventually break down into carbonates, limonite and quartz. That this has taken place to some extent is shown by analysis of the weather fragments. Here and there on the specimens

submitted were small cracks which were lined with a brown powder which was analysed qualitatively and was found to consist of calcium and magnesium carbonates and ferric oxide. Calcite is soluble in carbonated rain water and in presence of sulphur acids is converted into calcium sulphate. The absence of SO_3 in the analyses submitted indicates the absence of the latter condition. Pyrites is liable to oxidation to ferric sulphate and Rutile is unattacked under all normal conditions of weathering.

The depth to which weathering has occurred, as is clearly shown in the attached photomicrograph, is very small.

The effect of lichens.

Lichens are sometimes held to protect stone from decay since they shield the stone from the elements, and examples of lichen covered surfaces of soft limestone are known in England, which show the original tool marks beneath the lichens after 700 years exposure. Since, however, lichens hold moisture in contact with the stone, and, moreover, by their metabolism secrete organic acids, it may be regarded as a general rule that the presence of lichens tends to accelerate the rate of decay.

Microscopic examination of sections of the lichen covered sample shows that the stone is at present quite sound beneath the lichen, and though it might be slightly advantageous to remove any lichen growths with Ammonia as is suggested in the letter dated 22nd June 1926, the cost is likely to be out of all proportion to the advantage gained, and in any case, in a tropical climate, lichen growths would soon reappear.

In the letter dated 22nd June, 1926, a tentative suggestion is made caustic soda or caustic potash might be used to remove the lichens. It is desired therefore, to direct attention to the fact that the application of caustic alkalies to stonework is an extremely dangerous proceeding, and any process which involves the use of caustic alkalies is to be deprecated. Examples of stonework which have been treated by a "preservative" process involving the use of caustic alkalies are to be seen in England. The result has been disastrous and after no more than twelve months the stone has shown extensive decay.

The effect of the foliated character of the rock.

The rock is a crystalline schist and the minerals are arranged in more or less parallel lines or foliae. Under the microscope some sections exhibit more marked foliation than others. Though not exhibiting any marked schistosity whereby it may be easily cleaved, there must be planes of weakness parallel to the foliae, and if blocks of the rock are placed in the building with the foliae parallel to the exposed surface, corresponding to face bedding in a sedimentary rock, there will be a tendency to fracture in a direction parallel to the foliae.

If large blocks have broken away from the face of the building it is probable that this is due to the orientation of the blocks with the foliae parallel to the surface.

The lichen covered specimen submitted for examination was undoubtedly placed in such a position. The direction of the lines of foliation was confirmed by microexamination of a thin section. This specimen had evidentally been cracked

away from the main body of the stone in a plane parallel to the surface for a considerable time, for the fractured surface was covered with a brown film of the products of weathering.

Judging by the condition of the specimen under discussion it seems that such orientation does not induce surface flaking, but on the contrary it may be noted that surface flaking occurs quite independently of the lamination of the rock. One of the specimens submitted for examination showed such flaking, the direction of flaking following the curvature of the surface of the stone.

Condition of rain water gullies.

Decay by simple erosion may occur very rapidly if rain water is not efficiently conducted from the building, hence all rain water gullies should be kept in good repair. This point is advanced with some diffidence since there is no evidence to indicate how the structures are drained or that such repairs are necessary.

Replacement with new stone.

If there are any very badly decayed blocks in the buildings, due possibly to their orientation with the lines of foliation parallel to the surface, it is suggested that the most satisfactory method of dealing with them will be to replace them with new, carefully chosen stone, care being taken to place all such blocks with the lines of foliation at right angles to the exposed surface, preferably horizontally. If the question arises as to the desirability of replacing the old carving with modern work, it may be noted that it is the practice, at the present time, among those responsible for ancient buildings in England to avoid the replacement of old carvings as long as possible and, when such replacement

is absolutely necessary, to indicate in the new stone the form of the old carving rather than to attempt to make a detailed copy. In this way there is no possibility that at some future date the new carving will be confused with the old. The legitimacy of the method is, however, a matter of opinion. Detailed records of replacements and any other work, should, in any case, be kept for future reference.

Such a process of replacement would be gradual and, in the long run, would cost less than any "preservative" covering treatment, with far more permanent and satisfactory results.

Summary.

Microscopic examination shows that the rock is a talcose schist consisting mainly of talc with small quantities of calcite. pyrites and rutile.

Examination of the specimens submitted indicates that the extent of weathering is not great. Some erosion has occurred and also a certain amount of chemical decomposition causing the loss of small flakes of the material. Microsections have shown that the depth to which weathering has occurred is extremely small and have indicated that the lichens present are not causing sufficient damage to warrant the expense of their removal.

It is recommended that nothing in the nature of a surface treatment be adopted for the following reasons:-

(1, That no certain preservative is known.

(2) That so called "preservatives" often cause greater deterioration.

(3) That the talc schist which it is proposed to treat is so impermeable that the solution applied would not penetrate but would merely form a film on the surface.

(4) That the durability of any form of preservative treatment would be so small in comparison with the durability of the rock that such treatment, unless frequently renewed, would have little influence on the life of the building.

It is suggested that some of the observed decay may possibly be due to the orientation of the blocks with the planes of foliation parallel to the face of the building.

A suggestion is made that all water gullies should be kept in a good state of repair to reduce the possibility of surface erosion, and that the most satisfactory way of dealing with any very badly decayed blocks would be to replace them with new, carefully selected stone.

Figure 1.

Photomicrograph of a thin section of the lichen covered specimen submitted for examination showing the film of lichen growth, with a very small amount of decay beneath.

Magnification - 30 diameters.

Section Mura

File No. 126-26

Serial No. 16

Diary No. of letter replied to 267

No. Pol 858

General and Revenue Secretariat

(Muz)

the 192

To

The Secretary to the Hon'ble

the Resident in Mysore.

Sir,

Date of issue. 19.9.1927

Signed by: [illegible]

With ref I am directed to acknowledge, with thanks, the receipt of your letter No. 9103/252-19 dt 6.9.27, with its enclosures, on the subject of an enquiry into certain problems of stone decay and to state that the Comptr to Govt has been instructed to arrange for payment of £4/- into the Hon'ble the Resident's Treasur to the credit of the Govt of Ind.

List of enclosures

Copied by

Examined by

over

I have e.

WL C562 -GPB—31,000—17-8 25

17.9.27

Secretary

Department of Scientific and Industrial Research,
16, Old Queen St.
Westminster, S.W.1,
27th May 1927.

B.R.B.14/4/3

Sir,

~~Sir,~~ I am directed ~~xx~~ by the Committee of the Privy Council for Scientific and Industrial Research to transmit for action by the Secretary of State for India the enclosed copy of a Report by the Director of Building Research on the Preservation of Stonework in the temples of Belur and Halebid. This report is the outcome of an application received from the Engineer and Chemist at the Govern ment Soap Factory, Bangalore, which has been the subject of semi-official correspondence concluded with Mr. Wakely's letter of the 6th January 1927 (P.4551) and Sir Frank Heath's semi-official repl of the 13th January.

No charge is made for the communication of existing knowledge and technical information held available at the Building Research Station of this Department, and the only charge in connection with this ~~Report~~ Report is one of £4 covering the actual cos of making a section and photograph from specimens supplied. The Committee of Council regret that it was not possible to furnish an estimate of this charge in ~~advance~~ advance, but in view of it amount I am to express the hope that no difficulty has thereby bee occasioned.

The Department will be glad to receive in due course a payable order for the amount stated.

I am, &c.,

M.S. Lloyd.

The Under Secretary of State,
India Office, Whitehall, S.W.1.

Copy"
S Srinivasachar
Supdt, Mfg Branch

Note No. 115

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH.

PRESERVATION OF STONEWORK - TEMPLES OF BELUR AND HALEBID.

Sd/- .....

May 1927.

Director of Building Research,
Building Research Station,
Gareton, Herts.

PRESERVATION OF STONEWORK TEMPLES OF BELUR AND HALEBID.

Stone Preservatives.

During the last 70 years, many substances have been used in attempts to preserve stonework by surface treatment, and, at the present time, there is a large number of commercial stone preservatives on the market. Experience has shown that such substances are seldom satisfactory and though, in a few instances, surface treatmen may have appeared to be successful, or, at least, to have caused no harm, possibly even throughout the lifetime of those who applied it, it has been left to their successors to realise what irreparable damage was done. Examples of such ultimate damage naturally suggest that extreme care should be exercised before any process is recommend, even it is apparently successful. In most cases where preservatives have been used, observation has shown, either that the preservative has actually harmed the stone within a comparatively short time or that the stone has derived no material benefit from the treatm.

Unless the treatment renders the surface absolutely impervious at all points, a consummation almost impossible of realisation in practice, decay is liable to go on beneath the surface, causing the treated face to blister and eventually to flake off. Moreover, a point which is often overlooked is that the protective effect cannot be permanent and the treatment must be repeated from time to time. Though, for aesthetic reasons, it can seldom be used to protect work, probably the most satisfactory agent is ordinary paint and generally recognised that a paint coating requires renewal every years. If such a comparatively efficient and strong coating renewal, it is evident that the colourless protective coatings ly employed for treatment of stone, which are all less efficient paint, must be renewed at frequent intervals. The flaking and spalling which occurs when painted stonework is neglected, affords positive proof that surface treatment is worse than useless unless it is frequently repeated.

In the present state of our knowledge, therefore, and from gene considerations alone, It is impossible to recommend any surface treatment whatever because such treatment is unlikely to prove effective and it may, indeed, increase the tendency to decay and render the buildings extremely unsightly.

It is recognised that it is unsatisfactory to have to make statements of this kind and research on the whole question of stone decay and its prevention is in progress at the Building Research Station, but the nature of the problem is such that it cannot be hoped that any satisfactory method of preserving stone will be evolved in the near future

Even if a preservative were known which had definitely been proved to be efficient in normal circumstances, it is doubtful whether it could be recommended for the treatment of soapstone, since the stone is so impervious that the preservative would merely form a surface skin which would soon peel off, particularly under the action of tropical sun and rain. By partial immersion in water, specimens of the stone absorbed only 0.43% of their weight in seven days, and even after long boiling and subsequent cooling in water the absorption was only 0.47%

The extent of decay.- Without seeing either the buildings or detailed photographs, it is difficult to visualise the extent of the decay, but, judging from the specimens received, the extent of weathering is comparatively small, and the presence of lichens shows that the rate of decay must be extremely slow. In all probability, therefore, the decay which has already taken place has occurred after a long period of exposure, and the buildings are unlikely to show any marked increase in deterioration in the near future, in fact it is probable that the durability of any known "preservative" is so short in comparison with the durability of the stone that its application, soon, unless repeated at comparatively frequent intervals, would have no appreciable influence on the life of the building.

Thin section of the stone have been prepared and examined microscopically. These show that the rock consists mainly of talc, with small amounts of calcite and pyrites, and possibly rutile. Incidentally, the rock has been found to contain 0.73% TiO_2. Titanium is commonly used as an index of the extent of weathering and, had it been

been determined in the original analyses, would have been useful as such. In the present instance, the iron has served the purpose, b in any future analyses, TiO_2 might be determined separately.
Talc is exptremely resistant to weathering, but it may eventually break down into carbonates, limonite and quartz. That this has tak place to some extent is shown by analyses of the weather fragments. Here and there on the specimens submitted were small cracks which were lined with a brown powder which was found qualitatively and was found to consist of calcium and magnesium carbonates and ferric oxide. Calcite is soluble in carbonated rain water and in presence of sulphur acids is converted into calcium sulphate. The absence of SO_3 in the analyses submitted indicates the absence of the latter condition. Pyrites is liable to oxidation to ferric sulphate and Rutile is unattacked under all normal conditions of weathering

The depth to which weathering has occurred, as is clearly shown in the attached photomicrograph, is very small.

The effect of lichens. Lichens are sometimes held to protect stone from decay since they shield the stone from the elements, and examples of lichen covered surfaces of soft limestone are known in England, which show the original tool marks beneath the lichens after 700 years exposure. Since, however, lichens hold moisture in contact with the stone, and, moreover, by their metabolism secrete organic acids, it may be regarded as a general rule that the presence of lichens tends to accelerate the rate of decay.

Microscopic examination of sections of the lichen covered sample shows that the stone is at present quite sound beneath the lichen, and though it might be slightly advantageous to remove any lichen growths with Ammonia as is suggested in the letter dated 22nd June 1926, the cost is likely to be out of all proportion to the advantage gained, and in any case, in a tropical climate, lichen growths

lichens. It is desired therefore, to direct attention to the fact that the application of caustic alkalies to stonework is an extremely dangerous proceeding, and any process which involves the use of caustic alkalies is to be deprecated. Examples of stonework which have been treated by a "preservative" process involving the use of caustic alkalies are to be seen in England. The result has been disastrous and after no more than twelve months the stone has shown extensive decay.

The effect of the foliated character of the rock. - The rock is a crystalline schist and the minerals are arranged in more or less parallel lines or foliae. Under the microscope some specimens exhibit more marked foliation than others. Though not exhibiting any marked schistosity whereby it may be easily cleaved, there must be planes of weakness parallel to the foliae, and if blocks of the rock are placed in the building with the foliae parallel to the exposed surface, corresponding to face ~~marking~~ bedding in a sedimentary rock, there will be a tendency to fracture in a direction parallel to the foliae.

If large blocks have broken away from the face of the building it is probable that this is due to the orientation of the blocks with the foliae parallel to the surface.

The lichen covered specimen submitted for examination was undoubtedly placed in such a position. The direction of the lines of foliation was confirmed by microexamination of a thin section. This specimen had evidentally been cracked away from the main body of the stone in a plane parallel to the surface for a considerable time, for the fractured surface was covered with a brown film of the products of weathering.

Judging by the condition of the specimen under discussion it seems that such orientation does not induce surface flaking occurs but on the contrary it may be noted that surface flaking occurs quite independently of the lamination of the rock. One of the specimens submitted [illegible] has been found to contain 0.73% TiO_2 the diincidentally, the flaking for[illegible] index of the extent of weathering are of the stone commonly

Condition of rain water gullies.- Decay by simple erosion may occur very rapidly if rain water is not efficiently conducted from the building, hence all rain water gullies should be kept in good repair. This point is advanced with some diffidence since [illegible] is no evidence to indicate how the structures are drained or to what such repairs are necessary.

Replacement with new stone.- [illegible] if there are any very badly decayed blocks in the buildings, due possibly to their orientation with the lines of foliation parallel to the surface, it is suggested that the most satisfactory method of dealing with these will be to replace them with new, carefully chosen stone, [illegible] to place all such blocks with their [illegible] at right angles to the exposed surface, preferably horizontally. [illegible] of the suggestion drawn to the desirability of replacing [illegible] modern work, it may be noted on the one hand, [illegible] those responsible for [illegible] to avoid the replacement of old carved [illegible] on the other hand, [illegible] replacement is absolutely necessary, to [illegible] old rather than to attempt [illegible] there is no possibility [illegible] will be confused with the old. The [illegible] of replacement is, however, a matter of opinion. Detailed records of [illegible] any other work, should, in any case, be kept for future reference.

Such a process of replacement would [illegible] run, would cost less than [illegible] for more permanent and satisfactory [illegible].

Summary.- [illegible] to examination [illegible] the rock is talcose schist consisting mainly of talc with small quantities of chlorite, pyrites and rutile.

[illegible] of the [illegible] of vast area, is not [illegible] a certain point [illegible] flaked off the [illegible]

which weathering has occurred is extremely small and have indicat that the lichens present are not causing sufficient damage to warrant the expense of their removal.

It is recommended that nothing in the nature of a surface treatment be adopted for the following reasons:-

1. That no certain preservative is known.
2. That so called "preservatives" often cause greater deterioration.
3. That the talc schist which it is proposed to treat is so impermeable that the solution applied would not penetrate but would merely form a film on the surface.
4. That the durability of any form of preservative treatment would be so small in comparison with the durability of the rock that such treatment, unless frequently renewed would have little influence on the life of the building.

It is suggested that some of the observed decay may possibly be due to the orientation of the blocks with the planes of foliation parallel to the face of the building.

A suggestion is made that all water gullies should be kept in a good state of repair to reduce the possibility of surface erosion and that the most satisfactory way of dealing with any very badly decayed blocks would be to replace them with new, carefully selected stone.

Copy
S Drummalachas
Supt, Mus: Branch

. F. VI. Gl.]

JECT..... 3 & 15?

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Section Mcg

File No. 126-26

Serial No. 17

Diary No. of letter replied to . 267.

No. 464

General and Revenue Secretariat

( )

the *192*

To

The Comptr to Govt

Date of issue. 14-9-27

Signed by Mr M Venkatesa Iyengar

Sir,

In continuation of G.O

No. 1466-7/Mcg/126-26-8 & 5 2-27

sanctioning a sum of Rs 500 to be

placed at the disposal of the Mcg:

Comr: for meeting the charges in-

curred by the Industrial Chemist

in connection with the selection

and despatch of certain specimens

from the temples in Belur & Halebid

for examination by the experts

in Europe, the charge being met

from the Interest earnings of the

List of enclosures.....

Copied by ..

Examined by .....

over

Genl: Mtg: Fund, I am directed to request you to arrange for payment ~~of £ stg/-~~ from the same source of a sum of £4/. into the Hon'ble the Resident's Treasury to the credit of the Govt. of India to meet the actual cost incurred by the Department of Scientific and Industrial Research for making a section and photograph from specimens supplied -

I have etc

Secretary
Pol. Dept
15/9/27

89
15.9.27

Copy to Mtg: Comm. for inf. No 465 dy 15.9.27 for information -

By Order

Secretary
Pol. Dept
15/9/27

3815

Section Mesq
File No. 126-26
Serial No. 18

Diary No. of letter replied to .. 267.

No. 481 Enc one file

General and Revenue Secretariat
(Mesq)
the *192*

To

The Mesq: Comr & Chief ~~Engr of Mysore~~.

Date of issue. 24-9-27

Signed By: Venkatesa Iyengar

Sirs,

I am directed to forward herewith for a joint report from yourself & the Engr the ... considered necessary, copies of the ~~Report~~ Note no 115 by the Department of Scientific and Industrial Research, Building Research, London, on the subject of "Preservation of Stonework - Temples of Belur and Halebid", with a covering letter B. R. B. 14/4/3 & 27.5.27 & from Mr. M. S. Lloyd.

I have etc

List of enclosures.....

Copied by.....

Examined by .....

over

for Secretary

WD 0062 -GPB- 31,000- 17-8 25

SD 15/9/27 PJO

6828249-17 Enc one file
Copy to the Chief Engr.
for information and necessary
action.

By Order

Secretary
H. Dept.

89
17 9 27

3815

Section Mey

File No. 126-26

Serial No. 19

Diary No. of letter replied to .....

No. 483 Mysore Fde

General and Revenue Secretariat

( )

the *192*

To

S. G. Sastry, Esqr.,

Industrial Chemist, Govt. Soap Factory, Bangalore.

Date of issue. 26-9-27

Signed by M. Venkatarama Iyengar

Dear Sir,

I am ~~directed~~ desired to forward herewith a copy of the Note No 115 by the Director of the Department of Scientific and Industrial Research, Building Research, London, on the subject of "Preservation of Stonework - Temples of Belur and Halebid," and its covering letter no. B.R.B 14/4/3 dt 27.5.27 from Mr M. S. Lloyd, and to request ~~that the course which~~ as to what course you would recommend in view of the

over

List of enclosures.. .....

Copied by.. .. ..

Examined by ....

advice given in the Report, ~~may~~
be ~~reported to Govt~~.

Y. S. Thanvesto
16/9 Secretary
Fe Deptt

15/9/27

15/9/27

Enclosure.

Dated Bangalore, 10th December 192

From

P. G. D'Souza, Esq., P.A., P.L.,

Muzrai Commissioner in Mysore,

Bangalore.

SECRETARIAT
24 DEC 1927
MUZRAI
D - 816

To

Srinivasa Iyengar, Esq., P.A., P.L.,

Secretary to the Government of His

Highness the Maharaja of Mysore,

Financial Department.

Sir,

With reference to correspondence ending with your letter No.481/M.F.126-26-18 dated 24th September 1927 forwarding for a joint report by the Chief Engineer and myself a note by the Department of Scientific and Industrial Research, Building Research London, on the subject of the "Preservation of Stone work in the Temples of Pelur and Halebid", I have the honor to forward herewith copy of a "Paper" prepared by Mr S.G. Sastry, Industrial Chemist, and received in this office with letter No.D. Dis.116-27 dated 1st December 1927 from the Director of Industries and Commerce in Mysore and to state as follows.

2. There is no objection to the "Paper" being read at the next session of the Engineer's Association as the data collected and the theories advanced deserve wide publicity and thorough discussion. A perusal of the "Paper" however shows that investigations already made have not led to any final conclusions either as to the causes of the decay or the most effective remedial measures.

3. As regards the suggestion that the drains should be remodelled so as to stop the trickling of rain water over the images, the Public Works Department may be requested to take necessary action. Using cellulose acetate dissolved in ethel alcohol as varnish to the stones is too expensive as the immunity does not last for more than two years.

4. It seems to me that except in the way o
interesting scientific data, the researches of the
do not promise any practical results. As regards the inv
of the different varieties of lichens that grow up on the c
surfaces, such an investigation will have a purely academic interest

5. With the above observations, I submit the matter for further -
instructions of Government.

I have the honor to be,

Sir,

Your most obedient servant,

Muzrai Commissioner.

THE DECAY OF STONE WITH SPECIAL RLFERENCE TO BELUR AND HALEBID TEMPLES.

By

S.G. SASTRY, Esq., B.A., M.Sc. (Lond). F.C.S. F.M.U

The object of this paper is to place before the Mysore Engineers' Association certain facts and observations concerning the deterior-ation of the carvings in the temples of Belur and Halebid and to elicit from the members comments on what has been attempted and suggestions for future action. The author of this paper has been off and on devoting some attention to this problem and has also consulted some eminent authorities on the subject.

"The temple at Belur was erected and endowed by the Hoysala king, Vishnuvardhana, on the occasion of his exchanging the Jain faith for that of Vishnu, in the beginning of the 12th century. The carving with which the temple is decorated rivals in fertility of design and perfection of finish that of the Halebid temple, and is attributed to the same master hand, that of the famous Jakanachari.

"The most remarkable of the temples at Halebid are the Hoyasaleswara and Kedareswara temples. The latter was the smaller and a gem of art. But a banyan tree which had rooted itself in the Vimana or tower over the sanctum, dislodged the stones and many of the figures thrust out of the walls have been removed to the museum at Bangalore. The large Hoyasaleswara temple, though never completed, is in better preservation. The marvellous elaboration of ornamental sculpture round the walls and the general architectural effect, have elicited from the highest authority on these subjects that taken altogether it is perhaps the building on which the advocate of Hindu architecture would desire to take his stand" (Rice's Gazetteer).

The date of the Belur temple (Chennakeshava temple) is given as 1117 to 1141 A.D. That of Hoyasaleswara as 1047 - 1100 A.D. That of Kedareswara as 1219.

The stone that has been used for the temples at Belur and Halebid is what is locally known as Balapadakallu, pot stone or soap stone. It is a special variety of talc. Petrographically it falls under the class of rocks called "ultra basic rocks" and in particular to the variety of altered pyroxenites. It is one of the members of the Dharwar schist formation and as such of great geological antiquity. It is massive, compact, homogeneous and even grained, very tough and soft and admirably adapted for decorative carving. Some of the samples show a laminated structure. The colour of the stone varies from greenish grey to a bluey grey and the worked stone presents a dull sombre grey. The stone takes a very fine polish. It is said to stand weathering well and consequently the weathering now noticed must have been of very recent origin. The Chemical composition of the stone in various stages of preservation is given in the enclosed tables.

The average rainfall at Belur is 85.49 inches, the extremes during the last 16 years being 57.38 inches in 1912 and 31.05 inches in 1913. The extremes of temperature are 97.8°F maximum and 50.4°F minimum. The maximum was recorded towards the end of March and the minimum towards the beginning of January The temperature records refer to Hassan and may be taken to apply to Belur and Halebid also. The temples are located in places where there are no factories emitting smoke that might pollute the sorrounding atmosphere. The temples are exposed to South West monsoon. The North East monsoon does not generally travel as far interior as Belur and Halebid.

Those portions of the temple which are exposed to the monsoon are darker in appearance than other portions which are sheltered from the fury of the monsoon. The deterioration observed is more pronounced at the expose places than at others, even though there are some sheltered nooks in the Halebid temple where some of the carvings are in an advanced stage of decay. In such cases, one usually finds that the rain water from the roof is -- trickling down on the carvings and this might have assisted in the deterioration of the carving.

Generally speaking the decay proceeds in the following manner. The finely polished surface, on account of the battering of dust particles when there is a wind blowing at a high velocity, developes pin holes on the surface, scarcely visible to the naked eye. The same phenomenon might be brought about by the battering of rain drops when the South West monsoon breaks with all its fury. One will have to take into account the effect of hailstones pelting at these images during the several centuries of the temple's existence. When once the fine even polished surface becomes pitted other factors contribute towards further decay. The sequence of decay later on is probably as follows:- The pin holes become bigger at a later stage. These spots give shelter to dust particles and this is generally followed by the appearance of some low forms of vegetable growth. Minute traces of ammonia in the air will have a chance of collecting at these spots followed by oxidation into nitric acid. The action of nitric acid is well known under these circumstances and disintegration rapidly follows. In some of the sheltered places evidences of efflorescence were very clear and samples have been collected for further examination. The disintegration starts at the surface and later spreads, as it were, a layer below the surface, and at later stages the whole surface exfoliates, that is, the stone peels of in layers. On a close examination of a number of specimens, I was able to observe that before the layer actually crumbles down to the ground, the space between the outer layer and the main body of the stone is in a spongy condition. At a later stage the spongy condition disappears due probably to some of the salts being dissolved away by rainwater and the space will be occupied by dust particles and a number of insects. Incredible as it may seem I was able to observe with the help of a magnifying glass tiny spiders with their webs between these interstices, which would scarcely measure 1/10 of a millimeter.

It is undoubtedly true that in some cases the decay is primarily due to rain water trickling over the images. Recently some attention seems to have been given by the P.W.D. to this aspect but the drains require remodelling

remodelling in a number of places. That rain water trickling over images does harm is proved by the fact that inside the Belur temple, right in front of the Garbhagudi (Sanctorum Sanctum) there are several places where deterioration has progressed to a marked degree. When more systematic work is undertaken, the rain water should be analysed carefully.

10 Another cause of decay seems to be as follows:- If one examines the analytical figures of the stone closely, it will be found that the stone contains practically all the ingredients necessary for vegetable growth. As a matter of fact one is almost tempted to call this stone a fairly favourable "soil" for vegetable growth, the only difference between the ordinary soil and the stone being that the latter is in a very solid and compact form. Keeping this in mind and also taking into consideration that nitrates are also available (due to the oxidation of ammonia or the presence of traces of nitric acid in rain water during storms), and all the conditions necessary for vegetable growth are present. No wonder then that some low vegetable organisms develop and begin to grow. Add to this, the presence of very very small insects on these pitted surfaces and their subsequent death would furnish some more manure, as it were. The excreta of birds perching on many of these figures supply further material favourable to vegetable growth. The presence of moss or lichen cannot be, I think, explained in any other way.

Professor Kreuger of Stockholm University, who is working on the subject of decay of stones has conducted a few experiments on some of the specimens which I sent to him. He thought that one of the causes of decay might be due to a relatively cold rain falling on the surface when it is hot. I beg to be permitted to quote two sentences from his unpublished results.-

> "I have polished some samples and subjected them to 167°F in air alternating with water at 50°F. Every hundred time I have looked on the polished surface in a microscope. It seems as if it were possible to get a decomposition that way reminding of the decayed stones."
>
> Again "I have also ground the stone to a sharp edge subjecting it to alternating 75°C (167°F) air and 10°C (50°F) water to see the decomposition in a microscope. In that manner you will see the decomposition much faster as the edge is very thin and easily damaged."

No surface temperature of the carvings have been taken. It is no

doubt true that during the months of September and October it occasionally happens that a hot afternoon will be followed by a downpour of rain. Even though the surface temperature may be as high as 95°F before the rain-fall I am inclined to think that there will elapse generally at least half an hour during which time there will be a general lowering of the temperature of the atmosphere followed by cool winds. From this it follows that before the rain drop actually falls on the stone, its temperature would have been considerably lowered. In any case the range of temperatures adopted in Prof. Kreuger's experiments namely 167°F and 50°F will be out of question at Belur and Halebid. The utmost that we can concede is that there will be a difference of temperature between the stone and the rain drop. This difference will not be enough to make one think that rain drops falling on the stones will have a "quenching effect". Prof. Kreuger's work seems to indicate that he believes the decay is due to purely physical causes.

13 Dr. M.A. Sampathkumaran who paid a visit to these temples along with me and collected a few specimens of the lichen growing on the carvings in a private communication informs me that so far as he has been able to observe there are five kinds of lichens growing on these stones. He is of opinion that the earlier stages of decay are associated with a "crustose" type of lichen. "The soredia of these lodge themselves in the small pits or crevices of the stones and commence their destructive work. These are followed by another crustose type. Later the foliose types commence to do their portion of destruction which finally leave the stone in a crumbled condition." Dr. Sampathkumaran has informed me that further work can be undertaken only if proper facilities are afforded for collecting the specimens in various stages of development to work out their life history.

14 I conducted some experiments at Belur and Halebid to remove these lichen. I used a solution of ammonia. With the help of this it is easy to soften the lichen and remove them with a wooden spatula. But what happens under those circumstances is that by removing the lichen we shall be exposing fresh surfacesfor other weathering influences and the lichen are sure to appear a few years later. The Archeological Chemist to Government

of India suggested using dilute warm solutions of caustic soda or caustic potash and this drastic suggestion was not approved by me, so long ago as five years. Recently the Building Research Board in London have also warned us against the use of either caustic potash or caustic soda.

15 Mr. Bhatt, the Chief priest at the Belur temple, informed me during my last visit to Belur, that the lichens will be very soft during monsoon, and they can be easily removed by a rough brush. This may be so. But is it worth our while to remove the lichens? ~~That~~ This is one of the questions to be decided. The Building Research Board make the following observations on the effects of lichens.-

> "Lichens are sometimes held to protect stone from decay since they shield the stone from the elements, and examples of lichen covered surfaces of soft limestone are known in England, which show the original total marks beneath the lichens after 700 years of exposure. Since, however, lichens hold moisture in contact with the stone, and moreover, by their metabolism secrete organic acids, it may be regarded as a general rule that the presence of lichens tends to accelerate the rate of decay.
>
> "Microscopic examinations of sections of the lichen covered sample shows that the stone is at present quite sound beneath the lichen and though it might be slightly advantageous to remove any lichen growths with ammonia as is suggested .... the cost is likely to be out of all proportion to the advantages gained and in any case, in a tropical climate, lichen growth would soon reappear."

16 One or two observations are quite pertinant in this connection. The lichen itself cannot get a "foot-hold" if the stone images which have a wonderful polish and shine on them had not already become pitted. Therefore the statement that the stone beneath the lichen was "quite sound" must be interpreted in a restricted sense. In many places the carvings are so delicate that the growth of lichen has actually hidden away the beauties of the exquisite carvings. Further it is very difficult to believe that liches form a permanent protection. On the other hand one would strongly suspect at some stage or other the stone would exfoliate with the lichen. What should be done then under these circumstnces? One thought suggests itself. That is, to kill the lichen on the spot by means of some antiseptic ~~of~~ or germicide. This will prevent its further growth and if after killing it is left there, it may afford permanent protection to the images. I am hazaarding this view for one reason. Last time I visited Halebid, I had

hand long with me. The sun was bright and hot. I burnt away the surface of a few spots covered with lichen. The surface became slightly tarry and finally there was a layer of firmly adhering carbon and other matter where the lichen existed. It is very unlikely that anything else will grow on the same spot for a considerable time. Instead of burning away the lichen, the question is can we destroy its activities permanently, or fairly permanently without scraping it away?

17 In the early part of this paper the observed facts regarding the manner of decay were mentioned. It was said that ultimately the carvings peel off layer by layer, i.e. exfoliate. This is explained by what is known as the face-bedding theory. J.E. Marsh, in his book on "Stone Decay and its prevention" explains the theory as follows.-

> "It will be remembered that the 1839 Commission recommended, but not very insistently, that the stone should be laid in its natural bed. If we compare a stone to a book such as the Stock Exchange Year Book, which is nearly a cube, its natural bed will be with the pages horizontal. It may be up-ended and laid either with the edges of the leaves outwards or with the leaves themselves outwards. In the latter position it would be called face-bedded. It is not unnatural to expect such a building to decay by losing the leaves one at a time, that is by exfoliation as it is called. One's confidence in the face-bedding theory was a little shaken by finding the argument inverted, in the sense, that the decay of the stone was taken as a proof that the stone was face-bedded. A stone without any lamination and laid in its natural bedding plane exfoliates in just the same way. A cylindrical column of limestone of a foot or less in diameter is exfoliating in the same way in leaves of the same curvature as the column. There can be no question of a cylindrical bedding plane ..... "

18 The face-bedding theory does not hold in the case of stones of Belur and Halebid. During one of my visits I observed a stone, which is placed across two pillars, as a beam, exfoliating in two planes. Surely the beam cannot be face-bedded in two different planes at right angles to each other. Further the legs of many of the images are exfoliating in leaves of the same curvature as the legs. The Building Research Board who were consulted have recorded the same observations without committing themselves either for or against the theory. They do not seem to have abandoned the theory of face-bedding. I am of opinion that face-bedding theory does not apply in this case.

19 We should now pass on to another aspect of the problem. Can we prevent further decay of these stones? One of the first things that suggest

themselves is to protect the stone from atmospheric influences.

10 To prevent further decay I, at first, suggested that the images should be coated with some sort of paint or varnish which will not act on the stone, which will form a thin elastic layer, strong enough to withstand the pattering of the rain drops, impervious to moisture, not acted upon under the combined influence of air, moisture and sunlight; in addition to these the varnish should be capable of forming a colourless transparent film and should possess a high refractive index. A solution of cellulose acetate in ether and alcohol would answer all these specifications and as a matter of fact it seemed to be the ideal thing that was required. But the draw back was that it required renewing every two or three years and the cost would therefore be too high and not within the region of practical politics. Dr. Alexander Scott who was then engaged on some work connected with the preservation of museum specimens was consulted and he suggested the use of a proprietory article called "Duroprene" and this produced a dark film on the carvings and made them look ugly and moreover the film was not holding on to the stone surface as tenaciously as the film of cellulose acetate. The Executive Engineer, Hassan District, has recently tried another varnish but these are only temporary, very temporary remedies. If the cellulose acetate film could be a little more durable, besides possessing all the other required qualities, it would be an ideal varnish. Dr. Kreuger of Stockholm has suggested cerosin wax, but that will not do either.

11 In this connection mention should be made that the Belur temple has been white washed with lime twice or thrice before. The lime is getting carbonated and is peeling off, but in some places the surface underneath the lime wash seems to be very fresh. Lime wash generally conceals all the delicate features of carving. There are also places where lime wash has not prevented further decay.

12 The chief priest of the Belur temple has been trying an experiment with a paint prepared according to an old formula contained in an ancient palmyra Sanskrit work. The paint is fairly thick and coloured and it seems to be a mixture of oil and resins including lac resin. The ingredients are mentioned in a Sanskrit sloka, which also lays down that all the ingredients

ingredients should be properly cooked in a gentle fire.

లా తోనభిశ్వేరకుం భోక్తివ గుగ్గుళంబితే గుళ్ళం తథా॥
కేర్ట్లో థామద్దతస్యోలం పా, తయిలకేమ్ళు వచ్చిగా "

This composition may preserve the surface, but at the same time it discolours the surface.

23 From the above it is clear that one ought to be careful about surface treatments. The preservation of these ancient monuments, is a grave responsibility and one ought to be ten times sure before be suggests any remedy.

24 The replacement of many of the decaying carvings by faithfully copying them out has been suggested. But that aspect of the question can scarcely be dealt with in this paper.

25 One or two other remarks are to be offered before I close. The temple at Halebid, is on the whole much better preserved than the one at Belur. Is it possible that Halebid temple is of a later date than that of Belur. This is for archeologists to settle. Even the selection of the stone seems to have been made with great care at Halebid.

26 Another thing which requires looking into is the different varieties of soap stone that enter into the building. The colour varies from greenish grey to bluey grey. Chemical analysis does not help us much; though more careful analyses should be made. I have observed both at Belur and Halebid that the greenish grey variety is the one that is fast deteriorating. Further I have a specimen here of the greenish grey variety which shows the schistositic structure or the ramified structure in a marked degree.

Any helpful suggestions regarding the solution of this problem will be gratefully received.

Before I close I should take this opportunity of thanking the Muzrai Commissioner in Mysore for having afforded me facilities to visit these places to study the problem at first hand.

---- :o: ----

-Copy-

For Muzrai Commissioner

opy of letter No.1148 dated [illegible]
St, Government Soap Factory, Bangalore to the Director of
Commerce in Mysore, Bangalore.

Ref: your letter No. [illegible] of [illegible]

I have the honour to [illegible] the
the article of [illegible] with the terms of the
Wale:-), The [illegible] I [illegible]
commercial meaning of the word [illegible]. I have also
all [illegible] for the [illegible] of the Trading Concern [illegible]
I request you to [illegible] of the same to the [illegible]
circumstances [illegible]

I regret it is not [illegible] to [illegible] offer
many [illegible] house of repute, or even [illegible]
to be held [illegible] Trading Concern [illegible]
of doubtful [illegible]. If there are any more
special [illegible], I shall do [illegible]

I have taken [illegible] trouble [illegible]
the [illegible] of my time will [illegible]

.ope you will find the paper

obliged to you if you will be good enough to offer criticisms on the report.

C o p y

M. Clemanjus

For Murrai Commissioner.

CHEMICAL LABORATORY OF THE GOVERNMENT OF MYSORE.

Bangalore, 2nd February 1921.

Report on sample of Halebid rock

received on 17 th August 1920.

Registered No. and description.	Constituents on sample dried at 100° C.		per cent.
1133.	Silica	SiO_2	31.24
Rock used in Halebid temple.	Ferric iron.	Fe_2O_3	4.76
	Ferrous iron	FeO.	7.96
	Chromic oxide.	Cr_2O_3	1.61
	Alumina.	Al_2O_3	1.[illegible]
	Nickel oxide.	—	0.76
	Manganese oxide	MnO	1.19
	Cobalt.		Traces.
	Zinc.		"
	Calcium oxide.	CaO	[illegible].37
	Magnesia	MgO	30.14
	Sodium oxide.	Na_2O	0.33
	Potassium oxide.	K_2O	0.06
	Loss on ignition	H_2O Etc.,	12.[illegible]0
		Total	100.73

(S. B. Limaye) Chemical Analyst.

Countersigned.

(Sd) [illegible] Krishnayya.
22-2-21.

Copy - [illegible]

for Mineral Commissioner

Report on samples of Halebid rock determined by the Archaeological Chemist to the Government of India.

TABLE 1.

	(a) Original hard rock.	(b) Loose fragments in the decayed mass.	(c) Decayed (Powdered) portion.
SiO_2	41.00	40.72	5.05
Al_2O_3	3.00	7.27	1.00
Fe_2O_3	7.71	7.05	.05
FeO	6.59	5.83	7.16
MgO	29.55	30.07	33.03
CaO	3.03	2.15	4.54
Na_2O	0.01	[illegible]	0.01
K_2O	0.44	.11	2.50
H_2O	5.15	4.09	4.07
CO_2	2.00	2.09	7.11
P_2O_3	*	[illegible]	*
Cl	*	0.10	*
S	0.00	0.00	0.00
[illegible]	0.11		

* Not determined.

- Copy

for Mysore Commissioner

ological Chemist to the Government
of India.

Table I gives the percentage composition of [illegible] mentioned above. A superficial examination of these figures will [illegible] the impression that [illegible] the course of weathering. In order to find out the [illegible] main of the constituents [illegible] results should be recalculated [illegible] into details of these [illegible] constituents of the [illegible] taking Fe [illegible] culated on [illegible] that have [illegible] (f) shows the percentage loss [illegible] ertine [illegible] constituents [illegible] decomposition [illegible] [illegible] Weathered (Fe) [illegible]

[illegible]

columns (e) and (f) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Constituent.	%				
SiO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Al_2O_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe_2O_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FeO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MgO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CaO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na_2O	[illegible]	[illegible]	[illegible]		
K_2O	[illegible]	[illegible]	[illegible]		
H_2O	5.21	[illegible]	[illegible]	[illegible]	[illegible]
CO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	100.42	[illegible]	[illegible]	[illegible]	

[illegible]

2 Drafts

SUBJECT.....

Section Mer

File No. 126-26

Seria No. 21

No. 1121.

Diary No. of letter replied to.....816.....

General and Revenue Secretariat

(Mug)

the *192*

To The Mysr: Govt in myspore, Bangalore

Sir,

Date of issue.....13-1-28.....

Signed by.....

With reference to the correspondence ending with your letter No. C. 1189 of 22-23 & 22.12.27 forwarding copy of a Paper prepared by Mr S. G. Sastry, Industrial Chemist on the subject of decay of stone with special reference to Belur and Halebid Temples, I am directed to state that the Government have no objection to the Paper being read, as proposed, at the next session of the Engineers Association.

over Memo re

List of enclosures.....

Copied by.....

Examined by.....

WD 0562—GPB—31,000—17-8-25

4.1.28

2 Graphs

SUBJECT.....

Section Mun

File No. 126-16

Diary No. of letter replied to.....816.....

Seria No. 72

No. 1122 Income

To The Chief Engineer of Mysore, Bangalore

General and Revenue Secretariat

(Mun)

the 192

Sir,

Date of issue 13-1-27

I am directed to forward herewith ~~a copy of~~ an extract from ~~the~~ Paper prepared in by Mr. S. G. Sastri Industrial Chemist, on the subject of stone decay with special reference to Belur & Halebid Temples, and to request that such action may be taken for remodelling the drains referred to therein.

Signed by M. A. Ramaiya

List of enclosures.....

I have etc.

Copied by.....

Examined by.....

Secretary

for Dy. Secy.

14/1/27

over

WD 0562—GPL—31 000—17-8-25

14.1.27

FINANCE
11 FEB. 1928
No...

WD 1998—GPB—5,000—27-4-25

No. 1524/1

MYSORE PUBLIC WORKS DEPARTMENT,
CENTRAL OFFICE,

Dated Bangalore, 11/2/ *192* 8

13 FEB 1928
MUZRAI

D 1071

FROM

JOHN BHORE, Esq., A.M.I.C.E.,
Chief Engineer of Mysore,
Bangalore.

126-26-23

To

B. Srinivasa Iyengar, Esq., B.A., B.L.,
Secretary to Government of Mysore,
Financial Department, Bangalore.

SIR

Subject: - Prevention of decay and deterioration of Belur and Halebid Temples.

- - - - - -

With reference to your letter No. 1122/Muz. 126-26-22 dated the 13th January 1928, forwarding, for necessary action, an extract from a paper prepared by Mr. S.G.Sastry, Industrial Chemist, on the subject of stone decay with special reference to Belur and Halebid temples, I have the honour to forward herewith, for information, a copy of letter No. 3839 of the 30th idem, received from the Superintending Engineer, Shimoga Circle, reporting the action taken to remodel the drains therein referred to and also to prevent decay and deterioration of these two temples.

I have the honour to be,

Sir,

Your most obedient servant,

Chief Engineer of Mysore.

HAR/9th.

Letter No.5839 dated the 30th January 1928, from the Superintending Engineer, Shimoga Circle, to the Chief Engineer of Mysore, Bangalore.

With reference to Memorandum No.7003/1 dated 25th January 1928, forwarding extract of a paper by Mr.S.G.Sastry regarding Belur and Halebid temples, I have the honour to state that even before the receipt of your Memo I made a detailed inspection of the temple on the 26th instant with the Executive Engineer and the Sub-Division Officer and have given full instructions to attend to the drainage in this dry weather. The special establishment sanctioned in G.O.No.854-6/Muz.392-27 dated the 24th November 1927, will be employed on this as well as other works necessary to prevent decay and deterioration of this World-famous Temples.

"C o p y."

Chief Engineer of Mysore.

HMR/9th.

SUBJECT.....

.....

.....

Section Mez

File No. 126-26

Serial No. 24

No. 1686. Income

Diary No. of letter replied to.....1271.....

General and Revenue Secretariat

( )

the 192

Date of issue 25/2/28

Signed by Sh. P.K. Somasvara Iyer

To The Director, Govt. Analytical Laboratory, Singapore, Nungambakkam

Sir,

In continuation of this office letter no. 1121 Mez 126-26-21 & 10.1.28 re "Paper" prepared by Mr S.V. Sastri Industrial Chemist, on the subject of Peony, of Ahoor with reference to Belur and Halebid Temples I am directed to forward herewith, for information, a copy of letter no 1271 Mez 9.11.27 from Rao Sahib

List of enclosures.....

Copied by .....

Examined by .....

over